a tungsten silicide layer and a tungsten silicide nitride layer.

REMARKS

Favorable reconsideration of this application, as presently amended and in light of the following discussion, is respectfully requested.

Claims 28-62 are presently active; Claims 9-16 and 24-27 having been canceled, and Claims 28-62 having been added by way of the present amendment.

In the outstanding Office Action, Claims 9-12, 13-16, 24 and 27 were rejected under 35 U.S.C. §112, second paragraph, as being indefinite. Claims 9-12, 13, 15, 16 and 25-27 were rejected under 35 U.S.C. §102(e) as being anticipated by Agnello et al. (U.S. Patent No. 5,796,166). Claims 11, 14, 15 and 26 were rejected under 35 U.S.C. §103(a) as being unpatentable over Agnello et al, taken with Wolf ("Silicon Processing for the VLSI ERA"; vol. 2, Lattice Press). Claims 12, 16 and 17 were rejected under 35 U.S.C. §103(a) as being unpatentable over Agnello et al. in view of Kato (U.S. Patent No. 5,134,451).

In regards to the 35 U.S.C. §112, second paragraph, rejection, new Claims 28, 36, 40, 43, 48, 52, 57, and 58 define barrier metals as at least one of tungsten nitride WN_x, where x is an atomic fraction of N and comprises a range from 0.5 to 1.0, and tungsten silicide nitride WSi_yN_z, where y is an atomic fraction of Si and comprises a range from 0.01 to 0.2, and z is an atomic fraction of N and comprises a range from 0.02 to 0.2. Further, new Claims 31, 39, 42, 45, 51, 55, and 60 define CF_x, where x is an atomic fraction of F from 1 to 4. Thus, the new claims are definite, and the 35 U.S.C. §112, second paragraph, rejection has been overcome.

Briefly, the inventions of Claims 28, 36, 43, 48, 52, 57, and 58 define, respectively, a wiring structure, an electrode, a method of forming a wiring structure, a second method of

forming a wiring structure, a third method of forming a wiring structure, a method of forming a gate electrode, and a second method of forming a gate electrode in which all these devices and methods include or produce a barrier metal formed of at least one of tungsten nitride WN_x, where x is an atomic fraction of N and comprises a range from 0.5 to 1.0, and tungsten silicide nitride WSi_yN_z, where y is an atomic fraction of Si and comprises a range from 0.01 to 0.2, and z is an atomic fraction of N and comprises a range from 0.02 to 0.2.

In the applied prior art, Agnello et al. discloses a CMOS gate stack structure using a metal-silicon-nitrogen diffusion barrier, wherein the refractory metal is selected from Ta, W, Nb, V, Ti, Zr, Hf, Cr, and Mo.[1] The structure is SiO_2/poly-Si/diffusion barrier layer/conductor in which TaSiN is used as the diffusion barrier layer. By utilization of the gate stack structure, the CMOS stack in Agnello et al. restricts oxygen diffusion and restricts dopant diffusion from a doped region in the silicon substrate into the poly-Si gate structure. The TaSiN diffusion barrier in Agnello et al. is an annealed co-sputtered TaN and SiN film or a nitrogen-enriched sputter deposited Ta_5Si_3 film. Further, Agnello et al. disclose that binary nitrides are not suitable for diffusion barriers and are not suitable in gate stack applications due to oxidation and degradation of the high frequency performance of the device.[2]

Thus, it is clear that the barrier metal of the present invention as defined in independent Claims 28, 36, 43, 48, 52, 57, and 58 differs from the applied prior art in the teaching of binary nitride as suitable barrier metals and differs in that the present invention teaches a range of compositions for the ternary nitrides which form suitable barrier metals at concentrations of Si and N which are not taught or suggested in Agnello et al. For example, the TaSi N ternary nitrides in Agnello et al. have a range of Si atomic fraction from 0.21 to

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[1]Agnello et al., Abstract.

[2]Id., column 1, lines 37-57.

0.36 and a range of N atomic fraction from 0.25 to 0.48. While Agnello et al. disclose that other refractory materials such as W could replace Ta in the compositions[3], there is no teaching or suggestion that the atomic fractions of W for a barrier metal could be in the range recited in independent Claims 28, 36, 43, 48, 52, 57, and 58.

Thus, it is respectfully submitted that the independent Claims 28, 36, 43, 48, 52, 57, and 58 patentably define over the applied prior art of Agnello et al.

Claims 29-35, 37-42, 44-47, 49-51, 53-56, and 59-61 which depend directly or indirectly from independent claims 28, 36, 43, 48, 52, and 57 or 58, respectively, likewise are believed to patentably define over the prior art.

New Claim 62 defines an electrode of a circuit element formed on a semiconductor substrate, with the electrode including a polysilicon layer; a barrier metal formed on the polysilicon layer; and a metal layer formed on the barrier metal, such that the barrier metal includes either a tungsten layer and a tungsten nitride layer or a tungsten silicide layer and a tungsten silicide nitride layer. Agnello et al. does not teach or suggest a composite barrier layer including either a a tungsten layer and a tungsten nitride layer or a tungsten silicide layer and a tungsten silicide nitride layer. Other prior art of record has been considered, but was deemed no more relevant to the patentability of Claim 62 than the disclosure of Agnello et al. Thus, it is respectfully submitted that Claim 62 patentably defines over the applied prior art.

Thus, the present amendment addresses the issues raised in the Office Action.

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[3]Agnello et al., column 6, lines 23-28.

Consequently, in view of the present amendment and in light of the above discussions, the outstanding grounds for rejection are believed to have been overcome. The application as amended herewith is believed to be in condition for formal allowance. An early and favorable action to that effect is respectfully requested.

Respectfully submitted,

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